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An fMRI Investigation of Semantic and Phonological Naming Treatment in Aphasia

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Introduction

Treatments for naming impairments typically employ phonological or semantic approaches, although it remains unclear as to why certain individuals can show greater benefit from one approach over the other. The aim of the current study is to examine brain activity associated with successful semantic versus phonological based treatments of word retrieval using functional Magnetic Resonance Imaging (fMRI).

Procedures

The results of two right-handed female participants with aphasia are reported. P1 was 3.2 years post-stroke with moderate conduction aphasia, and a temporal lobe lesion extending to the temporo-parietal junction. P2 was 14.4 years post-stroke with a mild anomic aphasia. P2's lesion was larger and more anterior, involving parts of the left inferior and middle frontal gyri and precentral gyrus. A naming battery (476 items) was administered to determine treatment items prior to scanning. P1 produced more phonological (10.74%) than semantic errors (4.07%), whereas P2 produced more semantic (26.45%) than phonological errors (6.61%).

Participants received four weeks of therapy (three sessions per week), with MRI scans before and after treatment. Sessions alternated between Phonological Components Analysis (PCA; see Leonard et al., 2008), and Semantic Feature Analysis (SFA; see Boyle & Coelho, 1995). Imaging data were acquired with a 4T MRI scanner, using a behavioural interleaved gradient acquisition sequence. During the scan, participants overtly named 90 objects selected from the pre-tests: 30 'known' items, 30 'unknown' items treated using PCA, and 30 'unknown' items treated using SFA.

Results

Significant activations for clusters greater than 20 voxels ($p < 0.01$ uncorrected) in regions associated with language processing are reported for successfully named items post-treatment compared with incorrectly named items pre-treatment (see Table 1).

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Table 1. Peak activation clusters with MNI coordinates

	Contrast	Anatomical Region	Z-score	Cluster Size	x	y	z
P1	PCA (post) > Incorrect (pre)	Right Angular	4.23	67	40	-72	40
		Left Angular	4.09	112	-40	-65	43
		Left Precuneus	3.89	366	-7	-50	43
		Right Inferior Temporal	3.70	37	50	-50	-18
		Left Inferior Temporal	3.26	35	-43	4	-43
	PCA (post) < Incorrect (pre)	Right Middle Temporal	3.62	69	68	-32	4
	SFA (post) > Incorrect (pre)	Right Angular	4.37	70	40	-72	40
		Right Precuneus	4.10	303	4	-61	43
		Right Inferior Temporal	3.75	47	50	-54	-18
		Left Angular	3.68	47	-40	-65	43
		Right Middle Temporal	2.77	20	50	-68	-0
		Right Superior Frontal	2.76	20	14	50	25
	SFA (post) < Incorrect (pre)	Right SMA	3.32	25	11	7	72
		Right Precentral	3.26	31	58	-4	43
		Left Postcentral	3.21	70	-58	-4	43
P2	PCA (post) > Incorrect (pre)	Right Hippocampus	4.59	143	25	-40	11
		Right Anterior Cingulum	4.55	217	4	29	-0
		Left Precuneus	4.02	106	-22	-43	4
		Left IFG (p. Opercularis)	3.90	680	-50	18	14
		Left Medial Temporal Pole	3.87	22	-50	14	-25
		Left Parahippocampal	3.06	27	-11	-11	-25
	PCA (post) < Incorrect (pre)	Right Middle Temporal	5.18	625	58	-25	4
		Left Supramarginal	4.64	881	-54	-50	32
		Right Precentral	4.38	369	54	7	47
		Right Middle Cingulate	4.17	117	7	22	40
		Right Middle Frontal	3.81	45	43	43	22
		Right IFG (p. Orbitalis)	3.30	32	50	18	-7
	SFA (post) > Incorrect (pre)	Right Hippocampus	5.05	196	25	-40	11
		Right Anterior Cingulum	4.77	225	4	29	-0
		Left Hippocampus	4.24	116	-18	-40	4
		Left Medial Temporal Pole	3.96	31	-50	14	-25
		Left IFG (p. Triangularis)	3.91	650	-54	22	14
	SFA (post) < Incorrect (pre)	Right Precentral	4.60	354	54	7	47
		Right Middle Cingulum	4.17	27	7	22	40
		Right Middle Frontal	4.02	58	43	43	22
		Left Middle Cingulum	3.78	55	-4	-14	43
		Right SMA	3.62	22	7	7	61
		Right Postcentral	3.30	23	65	-0	22

Conclusions

The results suggest that different approaches to naming therapy rely on different underlying neural mechanisms, and that these mechanisms may differ depending on an individual's locus of breakdown and lesion location. For P1, successful naming of items treated with PCA predominantly increased activity in a left hemisphere network, in contrast to the right hemisphere activation in similar regions for items treated with SFA. For P2, successful naming of items treated with PCA decreased activity predominantly in the right hemisphere frontal and temporal regions, with increased activity in left perilesional regions and the hippocampus bilaterally. Both participants showed decreased activity in motor regions when naming items treated with SFA, as well as the

right middle temporal gyrus for PCA, which may represent increased efficiency of these regions during naming.

References

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